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# Calculating Decompression in Naval Special Warfare SEAL Delivery Vehicle Diving Operations Utilizing the Real Time Dive Planner

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## NOTICES



## TECHNICAL REVIEW AND APPROVAL

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The experiments reported herein were conducted according to the principles set forth in the current edition of the "Guide for the Care and Use of Laboratory Animals," Institute of Laboratory Animal Resources, National Research Council.

This technical report has been reviewed by the NMRI scientific and public affairs staff and is approved for publication. It is releasable to the National Technical Information Service where it will be available to the general public, including foreign nations.

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Currently, SEAL Delivery Vehicle (SDV) dry deck shelter (DDS) diving supervisors, in concert with their diving medical officer, have three options in calculating decompression:

1. Volumes 1 and 2 of the U.S. Navy Diving Manual (1,2),
2. CSMD procedures (3), and
3. the Dive Planner (4)

For a given dive, these different methods of calculating the decompression obligation could give three very different answers. Understanding which decompression schedule is the best for a given dive will ultimately be learned through experience, but understanding the reasons for each different decompression schedule is essential.

The Dive Planner (4) is the most flexible and yet the least known of the three methods of calculating decompression.

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Therefore, the goals of this report are to:

1. Explain the background of the Dive Planner (4).
2. Give some essential facts for the proper use of the Dive Planner (4).
3. Discuss the strengths and weaknesses of the Dive Planner (4).
4. Compare the differences in decompression schedules between Volumes 1 and 2 (1,2), CSMD (3), and the Dive Planner (4).
5. And lastly, to give realistic SDV/DDS diving scenarios, and compare the different decompression schedules of Volumes 1 and 2 (1,2), CSMD (3), and the Dive Planner (4) and give some recommendations on the most appropriate options.

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The opinions expressed in this report are those of the authors and do not reflect the official policy or position of the Department of the Navy, Department of Defense, or the U.S. Government.

## *DEDICATION*

*This report is dedicated to every Navy frogman who has ever been under pressure.*

## INTRODUCTION

Current SEAL Delivery Vehicle (SDV) teams frequently execute complex, physically arduous, and lengthy dives. These are frequently multilevel dives that involve multiple breathing gas switches (from air, to 0.7 $O_2/N_2$ mix, to 100% $O_2$), in cold water for up to 8-12 h duration. Calculating the decompression obligation is one critical step in the safe execution of these complex dives.

The Combat Swimmer Multi-level Dive (CSMD) procedures (3,5) have been the "workhorse" for calculating decompression obligations in SDV diving since the early 1980's (3). These procedures have been safely used on numerous SDV operations since that time.

The Real Time Dive Planner was approved for use in support of Naval Special Warfare (NSW) diving operations in May 1994 (6). Since that time, the Dive Planner (4) has been a very useful option/adjunct to calculating safe decompression in SDV diving operations. Therefore, as it currently exists the SDV Dry Deck Shelter (DDS) diving supervisor, in concert with the diving medical officer (DMO), has three options in calculating decompression:

1. Volumes 1 and 2 of the U.S. Navy Diving Manual (1,2),
2. CSMD procedures (3), and
3. the Dive Planner (4).

For a given dive, these three different methods of calculating the decompression obligation could give three very different answers. Understanding which decompression

schedule is the best for a given dive will ultimately be learned through experience, but understanding the reasons for each different decompression schedule is essential.

The Dive Planner (4) is the most flexible of the three methods of calculating decompression. It is also the least known. Therefore, the goals of this report are to:

1. Explain the background of the Dive Planner (4).
2. Give some essential facts for the proper use of the Dive Planner (4).
3. Discuss the strengths and weaknesses of the Dive Planner (4).
4. Compare the differences in decompression schedules between Volumes 1 and 2 (1,2), CSMD (3), and the Dive Planner (4).
5. Give realistic SDV/DDS diving scenarios, and compare the different decompression schedules of Volumes 1 and 2 (1,2), CSMD (3), and the Dive Planner (4) and give some recommendations on the most appropriate options.

## WHAT IS THE REAL TIME DIVE PLANNER?

The Dive Planner (4) is a nitrox decompression algorithm incorporated into a computer program. It is designed for planning a dive and calculating decompression, as follows:

- The diver's depth, bottom time, travel rate, and gas selection are entered interactively for each segment of the dive.
- For gas selection the diver may use air and/or an underwater breathing apparatus (UBA) with 0.7 atmospheres absolute (ATA) $O_2$ in $N_2$ (i.e., the MK 16).

- The Dive Planner (4) computes a decompression schedule as the dive progress is simulated.
- The dive can be as simple as a single bounce dive or as complicated as a multilevel dive with breathing gas being switched between air, and a 0:7 $O_2/N_2$ mix.
- At the end of all the dive segments representing the depth-time-gas profile, the user can simulate the diver's ascent to the surface by following the Dive Planner's (4) calculated decompression schedule.

**WHAT IS THE BACKGROUND OF THE DIVE PLANNER?**

The Dive Planner (4) computer program is based upon a probabilistic nitrox decompression algorithm that was developed at the Naval Medical Research Institute (NMRI) in Bethesda, MD. That algorithm has also produced a set of new tables (7) that is currently being reviewed by the Naval Sea Systems Command (NAVSEA). A number of factors that led to the new tables and to the Dive Planner (4) development:

- The general sense that the current tables are not equally safe across all depth - bottom time combinations.
- The incidence of decompression sickness (DCS) in 16,170 decompression dives was between 1.25% and 6%, and the risk of DCS increased with increasing bottom time (8).
- The experimental finding that deep long dives may require substantially more decompression time than the current tables indicate. For example, 150 feet of

seawater (fsw) 40-minute dive may require twice as much decompression time as the current tables list in order to be completed safely (9).

- Deep long dives, as listed in Volume 1 of the Dive Manual (1), are predicted to be unsafe by probabilistic models (10)
- The introduction of a modeling technique to predict DCS risk on a dive using formal statistical techniques, and from that produce tables at a given "safety level" (11,12)
- The NSW desire to have the ability to incorporate the final tables/algorithm into an underwater decompression meter (UDM) that could be worn by a combat swimmer/diver, and would be capable of multilevel diving and gas-switching.

Hence, the probabilistic decompression model was developed and incorporated into the Dive Planner (4). This model was calibrated using a large data base consisting of well-documented experimental chamber air and nitrox dives with a known outcome of DCS (13). An algorithm for computing decompression schedules at real time was also developed using this model (14). Both the model and the algorithm were successfully validated by a prospective dive trial consisting of greater than 700 dives (15). A large fraction of the validation series were typical NSW dives with multilevel profiles, gas switching between air and 0.7 ATA $O_2$ in $N_2$, and long shallow transits. The final model and the algorithm known as "USN-93" were developed using all of the data (greater than 3300 dives) (13,15). The Dive Planner (4) uses the same algorithm to compute

decompression schedules at 10-second intervals of the dive being calculated. It employs a concept called "conditional probability", which refers to the probability of a future event (in this case, DCS) occurring, given that no event has occurred up until the present moment. Therefore, the Dive Planner (4) is continuously assessing the risk of DCS.

The current model, USN93, underestimates the risk of DCS in dives with high $PO_2$ (i.e., LAR V diving) and is therefore not used to directly calculate decompression based on a 100% $O_2$ breathing gas. However, a safe decompression procedure using $O_2$ in a dry environment was developed by conducting a dive trial of 284 man-dives (17). The final procedure uses the model to compute the decompression schedule on air and then uses a rule to derive the $O_2$ time. This procedure adds the option of safely expediting decompression by conducting $O_2$ decompression stops in the DDS chamber. This procedure was approved by NAVSEA in May 1995 (18).

## WHAT IS "MODELING" AND WHAT DOES THIS HAVE TO DO WITH DECOMPRESSION?

There is still a great deal to learn about DCS. For example, very little is known about

- How the body absorbs and releases inert gas during compression and decompression
- How bubbles form and grow during decompression
- How bubbles produce DCS

- Why DCS is a random event

Because of this lack of knowledge, models were developed that predict DCS incidence. Without them, prediction would become a dangerously subjective exercise. Therefore, decompression models (many exist, including USN-93) attempt to relate input variables (depth, time, gas) to observed outcome (DCS incidence). They are truly best described as a "black box" that, when given a certain input, predict a given outcome. The model USN-93, with parameters estimated using the method of maximum likelihood, gives a "good fit" of the over 3300 experimental dives with 190 cases of DCS. In other words, this model accurately and consistently predicts the risk of DCS based upon the experimental dives after which it was modeled.

## STRENGTHS AND WEAKNESSES OF THE DIVE PLANNER

### *Strengths*

The strengths of the Dive Planner (4) are as follows:

1. The algorithm that runs the Dive Planner (4) was tested and validated in dives done at NMRI and the Naval Experimental Diving Unit (NEDU) in Panama City, FL using typical SDV profiles with long shallow transits, multilevel depths, and gas switching.
2. The Dive Planner (4) is the only probability-based model that runs fast enough to be useful.

3. The Dive Planner (4) fits existing data better than any other model developed, and is internally consistent.
4. The Dive Planner (4) is thought to give a "better/safer" decompression schedule than the current tables, for deep decompression dives. As stated in the Introduction, it was found that the deep decompression dives (i.e., 150 fsw for 40 min) produced an unacceptable rate of DCS, if the current tables were followed.
5. The Dive Planner (4) is able to compute dives using various gas mixtures:
   - Air alone,
   - 0.7 ATA $O_2$ in $N_2$ UBA alone, or
   - Air and 0.7 ATA $O_2$ in $N_2$ UBA.
6. The Dive Planner (4) is multilevel dive capable, which means that it is able to compute any combination of depth/bottom time segments.
7. The Dive Planner (4) continuously computes a decompression schedule as the dive progresses.
8. The Dive Planner (4) offers the option of safely expediting decompression by conducting $O_2$ decompression stops in the DDS chamber.

***Weaknesses***

The weaknesses of the Dive Planner (4) are as follows:

1. It shares the weaknesses of all decompression models. Like other models, the Dive Planner (4) is not physiologic and it "lumps" all DCS, regardless of type or severity.

2. It overestimates risk on long shallow square dives. This translates into shorter no-decompression (No-D) limits than the current tables for long shallow square dives, which may be overly conservative.
3. Its' 0.7 ATA $O_2$ in $N_2$ decompression schedules may be less conservative on dives with segments breathing a 0.7 ATA $O_2$ in $N_2$ mix at greater than 60 fsw than on shallow (< 60 fsw) 0.7 ATA $O_2$ in $N_2$ dives. The reason for this is that very few of these types of dives exist in the data banks of this model.

## SUMMARY OF DIFFERENCES IN DECOMPRESSION SCHEDULES BETWEEN THE U.S. NAVY DIVING MANUAL VOLUMES 1 AND 2 AND THE DIVE PLANNER

It is important to have an appreciation of the basic differences between the decompression schedules given by Volumes 1 and 2 of the U.S. Navy Dive Manual (1,2 ), and the Dive Planner (4). Therefore, in comparing air and 0.7 ATA $O_2$ in $N_2$ dives, both No-D and decompression dives, the following general comparisons can be made.

### Air/ No-D Dives

Compared with Volume 1 (1), the Dive Planner (4) generally gives shorter No-D limits for shallow air dives, but longer No-D limits for deep ($\geq$ 80 fsw) air dives.

### 0.7 ATA $O_2$ in $N_2$ /No-D Dives

Compared with Volume 2 (2), the Dive Planner (4) generally gives shorter No-D limits for shallow 0.7 ATA $O_2$ in $N_2$ dives, and very similar No-D limits for deep ($\geq$ 60 fsw) 0.7 ATA $O_2$ in $N_2$ dives.

Compared with air, 0.7 ATA $O_2$ in $N_2$ should have shorter No-D limits when deeper than 77 fsw (when breathing air deeper than 77 fsw the partial pressure of $O_2$ is greater than 0.7 ATA).

### Air/ Decompression Dives

Compared with Volume 1 (1), the Dive Planner (4):

- generally gives longer decompression schedules for air dives.
- Often has deeper stops.
- May have longer stops deeper, followed by shorter stops shallower (i.e., it may recommend decompression stops of 30 fsw/30 min and then 10 fsw/10 min).
- May not have stops every 10 fsw (i.e., it may recommend a 30-fsw stop, followed by a 10-fsw stop).
- Has certain threshold points, where for a few more minutes of bottom time, the decompression time increases greatly.

### 0.7 ATA $O_2$ in $N_2$ /Decompression Dives

- Compared with Volume 2 (2), the Dive Planner (4) generally gives shorter decompression schedules for 0.7 ATA $O_2$ in $N_2$ dives.

## ESSENTIAL FACTS IN UTILIZING THE DIVE PLANNER (4)

Use of the Dive Planner (4) is restricted to U.S. NSW diving operations only. The program/disk should not be given to or used by foreign militaries or governments. The Dive Planner (4) is not approved for non-NSW diving operations (salvage diving,

explosive ordnance disposal diving, underwater construction, ship's husbandry, etc.). In summary, the Dive Planner (4) is used by DMOs in support of U.S. NSW DDS/SDV operations only.

Only DMOs qualified in the use of the Dive Planner (4) by an approved course may use the Dive Planner (4). The DMO is highly encouraged to work closely with the DDS/SDV dive supervisors. The DDS/SDV dive supervisors will ultimately decide the decompression schedule for the divers - while the DMO's role is to make recommendations. Therefore, the DMO is encouraged to include the dive supervisor in every step of his use of the Dive Planner.

In planning diving operations with the Dive Planner (4) care must be taken to avoid exceptional exposure and unreasonable dives. The dive supervisor and DMO should remember that the Dive Planner (4) can be used to calculate decompression dives to a maximum depth of 190 fsw for air and 150 fsw for the MK 16. Dives to depths deeper than this may not be planned without the Chief of Naval Operations (CNO) approval. Additionally, the dive supervisor and DMO should be wary of any dive requiring lengthy decompression, as this may also qualify as an exceptional exposure dive.

Lastly, the Dive Planner (4) can simulate a dive that is otherwise unreasonable or impractical (e.g., an air dive with in-water decompression that well exceeds the time at which a set of SCUBA cylinders would run out of air).

The DMO may use the Dive Planner (4) to calculate the decompression obligation for any phase of the DDS/SDV operations. For example, the Dive Planner (4)

may be used to calculate the decompression for the DDS hangar crew breathing air only at 40 fsw for 2 h, or for the SDV crew itself breathing air and the MK 16 (or the MK 16 alone or air alone) and multilevel diving. It may also be used for divers in the transfer trunk or hyperbaric chamber of the DDS complex.

The Dive Planner (4) requires a computer with a 486-level microprocessor with a math coprocessor in order to perform the complex mathematical functions required by the decompression algorithm. A color screen to provide ease in recognizing the breathing gas for the different segments of the dive is desirable but not essential. Version 6.0 of the Dive Planner (4) is compatible with all Windows™ applications prior to Windows95™. The Dive Planner (4) is not compatible with Windows95™.

SDV operators must continue to use the CSMD procedures (3) to calculate decompression requirements while on the mission and away from the DDS complex. Specifically, they will continue to record the dive profile using the transit and excursion method outlined in the CSMD procedures (3). They should also note the deepest depths used during a transit (if <30 fsw), the exact depths and times of excursions (when possible), and the points where they changed breathing gases. At the end of the dive, once they have returned to the DDS complex, they will forward this dive profile information to the dive supervisor and DMO who will calculate their decompression using either the CSMD procedures (3) or the Dive Planner (4).

The DMO utilizing the Dive Planner (4) should enter each segment of the dive (the depth-time-gas segment information) that the SDV and/or DDS divers performed, as exactly as possible (without rounding-off) with the "follow" option set to "N" (No) (see

Appendix C for details). For example, if the SDV operators transit at a depth shallower than 30 fsw (as recommended by CSMD procedures (3) when tactically feasible) the DMO utilizing the dive planner may use the deepest depth attained (to the nearest fsw) during a particular transit period for calculation of the decompression obligation during that segment instead of using 30 fsw. Additionally, if the divers breathed through the MK 16 for a portion of the dive, then the DMO should enter this information onto the Dive Planner (4) and give them "credit" for breathing a higher $ppO_2$. Lastly, if the SDV operators completed an excursion and the Dive Planner (4) recommended a stop deeper than the depth that they return to for a transit depth, then the "follow" option must be set to "N" in order to accurately reflect the divers "missing" a stop while returning to their transit depth. The Dive Planner (4) will keep track of this "missed stop" and may adjust the final decompression schedule to account for it. This would not be a case of omitted decompression as long as the Dive Planner's (4) final decompression schedule was followed.

The DMO utilizing the Dive Planner (4) should enter "gas 2" (0.7 ATA $O_2$ in $N_2$) for all segments during which the diver's breathed the LAR V or the MK 16. Currently, NMRI is working to model 100% $O_2$ breathing and incorporate this as "gas 3". Until this is a part of the Dive Planner (4), however, the DMO may give credit for the increased $ppO_2$ in LAR V breathing by entering it as "gas 2" (knowing that the LAR V's $ppO_2$ is always greater than or equal to 0.7 ATA).

At the end of the dive, when the SDV operators and divers are in the DDS, the DMO should utilize any or all of the sources of information concerning decompression

including the U.S. Navy Dive Manual Volumes 1 and 2 (1,2), CSMD procedures (3), and the Dive Planner (4), and then recommend the best decompression schedule to the dive supervisor. The dive supervisor is responsible for conducting the dive, including deciding on the best decompression schedule to ultimately use. The NSW diving officer also approves the final decompression schedule and method.

Remember to enter stops taken to drain the DDS into the dive profile. It takes ~ 45 min to drain the DDS at 30 fsw and ~75 min at 20 fsw. In general, draining the DDS at 20 fsw is more beneficial for the divers in terms of decompression obligation.

Emphasis is given to 4 points in the Dive Planner User's Manual (19) (see Appendix C for details):

1. The "follow" option is set to "N" (No) for each segment of the dive done during the SDV operation.
2. Once all segments of the dive are entered, the decompression schedule should be calculated by simulating the diver's ascent to the surface by entering a depth of "0", a time of "0", and setting the "follow" option to "Y".
3. After surfacing, the DMO should review the dive profile by using the F6 key, because the actual decompression profile may change during the ascent due to the concept of conditional probability. It is this final decompression schedule that should be recommended to the dive supervisor.
4. The F4 key can be used to back-up one segment at a time. This can be especially useful in calculating the final decompression schedule. For example, after calculating the decompression schedule using air (as

described above), the F4 key can be used to "back-up" to the point just prior to leaving bottom, switch gas to the MK 16, and follow the decompression schedule for 0.7 ATA $O_2$ in $N_2$ to the surface. Again, the F6 key should be used to view the final decompression schedule. Switching to the MK 16 is one method the DMO has to expedite decompression.

The decompression schedule using 0.7 ATA $O_2$ in $N_2$ may be less conservative than the air decompression schedule, especially after 0.7 ATA $O_2$ in $N_2$ UBA dives at depths greater than 60 fsw. Note that the diver may use the MK 16 to perform the decompression stops (even if inside the DDS) as recommended by the Dive Planner (4). However, while this decompression schedule may be used to expedite decompression, it may involve taking a greater risk of DCS.

The dive supervisor and DMO should be aware that there is another method of expediting decompression when utilizing the Dive Planner (4). The dry decompression procedure using $O_2$ may be utilized, and is summarized as follows (for details see Appendix C of this report).

1. The SDV and/or Hangar crew divers are decompressed (on air) according to the recommendation of the Dive Planner (4) to the 40-fsw stop while in the hangar (usually there are no stops greater than 40 fsw). If recovered into the DDS hangar at a depth shallower than 40 fsw, then the divers are compressed on air to a depth of 40 fsw.
2. Once at 40 fsw, the divers are transferred to the dry hyperbaric chamber at depth, and placed on 100% $O_2$ via the BIBS mask.

3. The divers remain in the chamber at 40 fsw on 100% $O_2$ (25 min on $O_2$ and 5 min on air) for a time determined by "$O_2$ Time". The $O_2$ time is calculated as follows (with the Air TDT always calculated by the Dive Planner (4)):

   - If Air TDT $\leq$ 125 min: $O_2$ Time = 25 min
   - If Air TDT > 125 min: $O_2$ Time = Air TDT $\div$ 5

4. Once the required $O_2$ time is complete, travel to the surface at a rate of 30-60 ft/min. Divers come off $O_2$ upon reaching surface.

When using the Dry Decompression Procedure Using $O_2$ (as outlined above) the "minimum" 25-minute $O_2$ period may be shortened as follows:

- In an emergency situation (when the Dive Planner's (4) recommended Air TDT is less than or equal to 125 minutes) and with DMO approval, the initial 25 min of $O_2$ time may be shortened. In this case, the DMO may recommend simply dividing the Air TDT by 5 to compute the $O_2$ Time.

In the event of computer failure or any difficulties with the Dive Planner program (4), the diver's decompression will be calculated using the CSMD procedures (3) or as directed by Volumes 1 and 2 (1,2).

Version 6.0 of the Dive Planner (4) gives an exit state at the completion of a dive and allows for the entry of that exit state and a surface interval at the start of a repetitive dive. These repetitive dive groups are not interchangeable with the exit states or groups of either Volumes 1 and 2 (1,2) or CSMD (3).

Divers whose decompression is to be computed using the Dive Planner (4) should not be considered "clean" if they have had any dives in the last 18 h prior to the start of the dive.

Dive profiles should be saved after they are entered. Profiles should be identified by the date, the location in the complex, and the profile's sequential number of those used on that date. A sample profile name is shown below:

940425H1

where:

94 represents the year;
04 represents the month;
25 represents the day.
H indicates it is a profile for the hangar crew;
(S=SDV; T=trunk; C=treatment chamber; M=mission specialist)
1 denotes the first profile computed in the hangar that day

An additional 50 characters are available for the DMO to further describe and classify the dive as necessary.

## SUMMARY

Currently, the SDV DDS diving supervisor, in concert with the DMO, has three options in calculating decompression:

1. Volumes 1 (1) and 2 (2) of the U.S. Navy Diving Manual.

2. CSMD procedures (3), and

3. the Dive Planner (4).

For a given dive, these three different methods of calculating the decompression obligation could give three very different answers. Understanding which decompression

schedule is the best for a given dive will ultimately be learned through experience, but understanding the reasons for each different decompression schedule is essential.

Appendix A is a problem set. The completion of these problems is essential for understanding the basics of the Dive Planner (4) and its use in support of NSW diving operations. The problems were carefully selected to give a feel for how the Dive Planner (4) will handle certain diving profiles, and how these same dives would be handled by Volumes 1 (1) and 2 (2) and by CSMD (3). The last portion of the problem set includes realistic DDS/SDV diving scenarios.

Appendix B contains the answers to the problem set, including some recommendations on the most appropriate options for decompression given realistic DDS/SDV diving scenarios.

Appendix C is the computer user's manual (19) for the most recent version (Version 6.0) of the Dive Planner (4) approved by NAVSEA in June 1996 (20). It also includes the in-depth instructions for the use of the dry decompression procedure using $O_2$ to expedite decompression.

In conclusion, it is strongly encouraged to experiment with the Dive Planner (4). It is an interactive computer program that is best understood by "doing".

Any difficulties encountered in the use of the NSW Dive Planner (4) or more specific questions and comments should be referred to Ms. Shalini Survanshi at (301)295-5898 or LCDR Dan Valaik at (301)295-5776 (DSN 295-5776). In case of an emergency, a NMRI DMO can be reached 24 hours a day at (301)295-1839/5875 (DSN 295-1839/5875).

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# APPENDIX A

# NSW DIVE PLANNER PROBLEM SET

## APPENDIX A

## NSW DIVE PLANNER PROBLEM SET

In order to complete this problem set you will need the following:

- A computer with the Real Time Dive Planner Program (4).
- CSMD Procedures (3)
- Volumes 1 and 2 of the U.S. Navy Dive Manual (1,2) (often referred to as 'Volume 1' or 'Volume 2')

You should do the homework in the order that it is presented, as each step builds upon the previous one. Once completed, your answers should be compared to the answers found in Appendix B.

---

1. Read the Real Time Dive Planner User's Manual (Appendix C). Experiment with the Dive Planner as you read and become familiar with the Run and File commands. Do the example at the end of the manual and print out your "Dive Scenario Summary". It should look exactly like the summary listed in the Dive Planner User's Manual Appendix C).

2. a. In Volume 1, look up the no-decompression limits for air for the following depths and fill in the blanks:

**Volume 1 - Air - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 30 | Infinity |
| 40 | _____ |
| 60 | _____ |
| 80 | _____ |
| 100 | _____ |
| 120 | _____ |
| 140 | _____ |
| 160 | _____ |
| 180 | _____ |

b. Using the Dive Planner, calculate the no-decompression limits for air for the following depths and fill in the blanks (Hint: By entering the desired depth of the dive and a time at depth of 0, the remaining no-decompression time will be listed on the screen as "NOD time: xx". The actual No-D time recommended by the Dive Planner will be within 1 min of this time plus the descent time.):

**Planner - Air - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 30 | 244 |
| 40 | ____ |
| 60 | ____ |
| 80 | ____ |
| 100 | ____ |
| 120 | ____ |
| 140 | ____ |
| 160 | ____ |
| 180 | ____ |

**OBSERVATIONS:**

3. a. In Volume 2, look up the no-decompression limits for 0.7 ATA $O_2$ in $N_2$ for the following depths and fill in the blanks:

**Volume 2 - 0.7 ATA $O_2$ in $N_2$ - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 40 | 367 |
| 60 | ____ |
| 80 | ____ |
| 100 | ____ |
| 120 | ____ |
| 140 | ____ |

b. Using the Dive Planner, calculate the no-decompression limits for 0.7 ATA $O_2$ in $N_2$ for the following depths and fill in the blanks (Hint: By entering the desired depth of the dive and a time at depth of 0, the remaining no- decompression time will be listed on the screen as "NOD time: xx". The actual No-D time recommended by the Dive Planner will be within 1 min of this time plus the descent time.):

**Planner - 0.7 ATA $O_2$ in $N_2$ - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 40 | 240 |
| 60 | ____ |
| 80 | ____ |
| 100 | ____ |
| 120 | ____ |
| 140 | ____ |

**OBSERVATIONS:**________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

________________________________________________________

4. a. In Volume 1, look up the decompression schedule for the following three air decompression dives. Fill in the blanks:

**Volume 1 - Air - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 10/26 | 26 |
| 2. 150/30 | ____<br>____ | ____ |
| 3. 150/40 | ____<br>____<br>____ | ____ |

b. Using the Dive Planner, look up the decompression schedule for the following three **Air** decompression dives. Fill in the blanks:

**Planner - Air - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 30/10<br>20/15<br>10/25 | 50 |
| 2. 150/30 | ____<br>____<br>____<br>____ | ____ |
| 3. 150/40 | ____<br>____<br>____<br>____<br>____ | ____ |

**OBSERVATIONS:**______________________________________________

5. a. In Volume 2, look up the decompression schedule for the following two 0.7 ATA $O_2$ in $N_2$ decompression dives. Fill in the blanks:

**Volume 2 - 0.7 ATA $O_2$ in $N_2$ - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 10/:25 | 25 |
| 2. 100/60 | ______ | ____ |
| | ______ | |
| | ______ | |

b. Using the Dive Planner, look up the decompression schedule for the following two 0.7 ATA $O_2$ in $N_2$ decompression dives. Fill in the blanks:

**Planner - 0.7 ATA $O_2$ in $N_2$ - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | ______ | ____ |
| | ______ | |
| 2. 100/60 | ______ | ____ |
| | ______ | |

**OBSERVATIONS:**________________________________________

6. Using the Dive Planner enter the following dive segment: Depth of 190 fsw and a Bottom Time of 50 min. while breathing air.

At this point note, the air TDT from the upper (air) line. Write down the recommended stops at this point in the dive:

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 190/50 | _____ | _____ |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |

Next, simulate the diver's ascent to the surface by entering a depth of 0, a time of 0, and setting the "follow" option to "Y".

After surfacing, review the dive profile by using the F6 key. Record this final decompression schedule below:

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 190/50 | _____ | _____ |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |
| | _____ | |

**OBSERVATIONS** (please note why this change in decompression schedules occurs, and which schedule you would recommend to the dive supervisor for the diver's decompression):

**SCENARIO** - DDS HANGAR CREW

1. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The DDS hangar crew must launch and recover the SDV. They will be doing the following dive profile on air: 40 fsw for 2 h (launch SDV) - 0 fsw for 2 h (surface interval) - 40 fsw for 2 h (recover SDV). Plan the dive schedule using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates:________________________________________

CSMD indicates:________________________________________

Dive Planner indicates:________________________________________

You recommend the following course of action:

Your reasons for this recommendation:

**SCENARIO** - SDV CREW / STANDARD SHIP ATTACK

2. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV crew returns from a successful ship attack and reports the following multilevel dive profile:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 29/43 | Air | SDV launch from DDS |
| 18/129 | Air | Transit |
| 21/62 | MK 16 (0.7) | Transit to Target |
| 50/21 | MK 16 (0.7) | Actions on Target |
| 21/60 | MK 16 (0.7) | Transit from Target |
| 16/120 | Air | Transit |
| 31/48 | Air | SDV recovery to DDS |

Calculate the decompression obligation for this dive using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates:________________________________________

________________________________________________________

CSMD indicates:

| Seg # | Transit/ Excursion | Max Depth (fsw) | Time of Segment (Min) | Decompression Time (min) 30 fsw | 20 fsw | 10 fsw | Shallow Interval (Min) | Ending Repet Group |
|---|---|---|---|---|---|---|---|---|
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| ___ | ______ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |

Dive Planner indicates:________________________________________

________________________________________________________

You recommend the following course of action:

________________________________________________________

________________________________________________________

Your reasons for this recommendation:

________________________________________________________

________________________________________________________

**SCENARIO** - SDV CREW / DEEP LAUNCH & RECOVERY

3. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV crew returns after the following multi-level dive and ship attack, with a deep launch and recovery:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 100/40 | Air | SDV launch from DDS |
| 20/120 | MK 16 (0.7) | Transit |
| 50/20 | MK 16 (0.7) | Actions on Target |
| 20/120 | MK 16 (0.7) | Transit |
| 100/40 | Air | SDV recovery to DDS |

They report that both of their gas switches occurred at 20 fsw. That is, they stayed on air during their launch phase until arriving at 20 fsw, and for their recovery phase they switched back to air just prior to leaving 20 fsw.

Plan this dive using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates:________________________________________

__________________________________________________________

__________________________________________________________

CSMD indicates:

| Seg # | Transit/ Excursion | Max Depth (fsw) | Time of Segment (Min) | Decompression Time (min) 30 fsw | 20 fsw | 10 fsw | Shallow Interval (Min) | Ending Repet Group |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

Dive Planner indicates:________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

__________________________________________________________

You recommend the following course of action:

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

Your reasons for this recommendation:

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

**SCENARIO** - DRY DECOMPRESSION PROCEDURE USING OXYGEN

4. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV crew has just completed the same dive as before (see Scenario 3) except on air only. The exact dive profile is as follows:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 100/40 | Air | SDV launch from DDS |
| 20/120 | Air | Transit |
| 50/20 | Air | Actions on Target |
| 20/120 | Air | Transit |
| 100/40 | Air | SDV recovery to DDS |

As the DDS hangar door closes there is an urgent request from the hangar to stop. The operator in the bubble then communicates that one of the SDV operators has his foot trapped in the door and that it is bleeding profusely. His foot is cleared from the doorway and the hangar door finally closes. You are unsure of the exact medical situation, but you realize that you must expedite decompression.

Plan this dive's decompression obligation as quickly as possible using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates: The same schedule as calculated in Scenario 3 (above).

CSMD indicates: The same schedule as calculated in Scenario 3 (above).

Dive Planner indicates: ______________________________

______________________________

______________________________

______________________________

You recommend the following course of action:

______________________________

______________________________

______________________________

Your reasons for this recommendation:

______________________________

______________________________

______________________________

**SCENARIO** - UNEXPECTED DEPTH EXCURSION

5. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV Task Unit onboard is in the beginning stages of their pre-deployment work-up and is practicing SDV launches and recoveries from the DDS. There are 12 men on the dive (this includes the hangar crew and the SDV operators) and everyone is breathing air. All have been working for the past 116 min between 30 and 40 fsw, when the submarine loses depth control. The submarine dives to exactly 70 fsw (the greatest depth for the divers) where it levels off for 4 min. It loses depth control again, and goes straight to the surface. The commanding officer tells his conning officer to come to "all stop" and keep the submarine on the surface in order to accurately assess the situation.

The dive supervisor immediately communicates with the men in the DDS. He confirms a count of 12 men and that there are no injuries to report: everyone feels fine and is asymptomatic for either DCS or A.G.E. In fact, they report enjoying the hot sunshine on the deck of the submarine.

But the DDS dive supervisor is concerned. He turns to you and states, "I think we have 12 divers with omitted decompression, what should we do?"

You begin to calculate these divers' decompression obligation using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates:____________________________________________

CSMD indicates:______________________________________________

Dive Planner indicates:________________________________________

You recommend the following course of action:

Your reasons for this recommendation:

**SCENARIO-** "SAVE THE TENDER"

6. You are the DMO underway on a DDS-capable submarine, in support of NSW DDS/SDV operations. A real-world operation calls for a U.S. Marine Corps forced reconnaissance and SDV task unit DDS insertion. They are planning a combined USMC and SDV Mass Swimmer Lock-Out (MSLO). At periscope depth, the divers will lock-out 2 small inflatable rubber boats, 2 outboard motors, fuel, and operational equipment. Five SEALs and five Marines will lock-out, each breathing air from a single-80 SCUBA cylinder.

During the operation, however, one of the Marines gets entangled in the ascent line with the buoy. He panics and mistakenly inflates the buoy. This causes him to ascend rapidly to the surface and he forgets to exhale all the way from 40 fsw to the surface.

On the surface he is unconscious with blood coming from his mouth. One of the SEALs activates his lifejacket, opens his airway, and signals the submarine that he has a medical emergency. You diagnose an A.G.E. through the periscope, and tell your best DMT to prepare for a difficult treatment table.

A MK 20 AGA full face mask is placed over the stricken diver's face. His airway is opened, his lifejacket deflated, and he is swum into the DDS complex for treatment.

You confirm that a pulse is present as the stricken marine enters the treatment chamber and you compress the chamber to 60 fsw at 25 fpm. After 15 min at 60 fsw the corpsman reports that the marine is deteriorating - his pulse has become irregular and his systolic BP has dropped from 100 to 60. You decide to go to 165 fsw on air. Initially, the marine improves and then, without warning he becomes pulseless and apneic. The corpsman performs flawless CPR, gives fluid boluses, and ACLS medications at your direction, but after 30 min of CPR the marine remains pulseless. You pronounce him dead and begin to discuss the series of events with the commanding officer of the submarine.

The dive supervisor interrupts your conversation and says "We still have to get the tender out of there! He was at 60 feet of seawater for 15 minutes and then 165 feet of seawater for 40 minutes. According to Volume 1 of the U.S. Navy Dive Manual he needs to come out on a Treatment Table 4 (TT4), and that takes 36 hours and 41 minutes. Is there any way to get him out faster and still safely?"

You realize that the dive supervisor is exactly right - because you went past 30 min at 165 fsw, Volume 1 now calls for a TT4. You begin to calculate your options for safely decompressing this tender. You consider using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates:______________________________________________

CSMD indicates:

Dive Planner indicates:

You recommend the following course of action:

Your reasons for this recommendation:

**SCENARIO-** SAFELY MAXIMIZING BOTTOM TIME AND MINIMIZING DECOMP.

7. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SEAL officer-in-charge comes to you and says, "I can't tell you much, but I need to do an operation at 150 feet of seawater for 40 minutes. I can breath air or the MK 16 or switch back and forth at almost any time during the operation. I need to know how I can safely maximize my bottom time and minimize my decompression time."

You begin to calculate the options using Volume 1 and 2, CSMD, and the Dive Planner. You come up with the following:

Volume 1 indicates:________________________________________

Volume 2 indicates:________________________________________

CSMD indicates:________________________________________

Dive Planner indicates:________________________________________

You recommend the following course of action:

Your reasons for this recommendation:

# APPENDIX B

# NSW DIVE PLANNER PROBLEM SET

# ANSWER-SHEET

## APPENDIX B

## NSW DIVE PLANNER
## PROBLEM SET ANSWER-SHEET

2. a. In Volume 1, look up the no-decompression limits for Air for the following depths and fill in the blanks:

**Volume 1 - Air - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 30 | Infinity |
| 40 | 200 |
| 60 | 60 |
| 80 | 40 |
| 100 | 25 |
| 120 | 15 |
| 140 | 10 |
| 160 | 5 |
| 180 | 5 |

b. Using the Dive Planner, calculate the no-decompression limits for air for the following depths and fill in the blanks (Hint: By entering the desired depth of the dive and a time at depth of 0, the remaining no-decompression time will be listed on the screen as "NOD time: xx". The actual No-D time recommended by the Dive Planner will be within 1 min of this time plus the descent time.):

**Planner - Air - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 30 | 244 |
| 40 | 143 |
| 60 | 64 |
| 80 | 38 |
| 100 | 27 |
| 120 | 21 |
| 140 | 17 |
| 160 | 14 |
| 180 | 12 |

**OBSERVATIONS:**

- Compared with Volume 1, the Dive Planner generally gives shorter No-D limits for shallow Air dives, but longer No-D limits for deep (> 80 fsw) air dives.

3. a. In Volume 2, look up the no-decompression limits for 0.7 ATA $O_2$ in $N_2$ for the following depths and fill in the blanks:

**Volume 2 - 0.7 ATA $O_2$ in $N_2$ - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 40 | 367 |
| 60 | 74 |
| 80 | 39 |
| 100 | 27 |
| 120 | 19 |
| 140 | 13 |

b. Using the Dive Planner calculate the no-decompression limits for 0.7 ATA $O_2$ in $N_2$ for the following depths and fill in the blanks (Hint: By entering the desired depth of the dive and a time at depth of 0, the remaining No- decompression time will be listed on the screen as "NOD time: xx". The actual No-D time recommended by the Dive Planner will be within 1 min of this time plus the descent time.):

**Planner - 0.7 ATA $O_2$ in $N_2$ - No-D**

| Depth (fsw) | No-D Limit (min) |
|---|---|
| 40 | 240 |
| 60 | 78 |
| 80 | 39 |
| 100 | 26 |
| 120 | 19 |
| 140 | 14 |

**OBSERVATIONS:**

- Compared with Volume 2, the Dive Planner generally gives shorter No-D limits for shallow 0.7 ATA $O_2$ in $N_2$ dives, and very similar No-D limits for deep (> 60 fsw) 0.7 ATA $O_2$ in $N_2$ dives.

- Compared with air, 0.7 ATA $O_2$ in $N_2$ should have shorter No-D limits when deeper than 77 fsw (because when breathing air deeper than 77 fsw the partial pressure of $O_2$ is greater than 0.7 ATA).

4. a. In Volume 1, look up the decompression schedule for the following three air decompression dives. Fill in the blanks:

**Volume 1 - Air - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 10/26 | 26 |
| 2. 150/30 | 20/08<br>10/24 | 32 |
| 3. 150/40 | 30/05<br>20/19<br>10/33 | 57 |

b. Using the Dive Planner, look up the decompression schedule for the following three air decompression dives. Fill in the blanks:

**Planner - Air - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 30/10<br>20/15<br>10/25 | 50 |
| 2. 150/30 | 40/05<br>30/15<br>20/05<br>10/05 | 30 |
| 3. 150/40 | 50/05<br>40/10<br>30/25<br>20/35<br>10/75 | 150 |

**OBSERVATIONS:**

- Compared with Volume 1, the Dive Planner:

1. generally gives longer decompression schedules for air dives.
2. often has deeper stops.
3. may have longer stops deeper, followed by shorter stops shallower.
4. may not have stops every 10 fsw (i.e., it may recommend a 30 fsw stop, followed by a 10-fsw stop).
5. has certain "threshold points", where for a few more minutes of bottom time, the decompression time increases greatly.

5. a. In Volume 2, look up the decompression schedule for the following two 0.7 ATA $O_2$ in $N_2$ decompression dives. Fill in the blanks:

**Volume 2 - 0.7 ATA $O_2$ in $N_2$ - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 10/25 | 25 |
| 2. 100/60 | 30/07<br>20/28<br>10/28 | 63 |

b. Using the Dive Planner, look up the decompression schedule for the following two 0.7 ATA $O_2$ in $N_2$ decompression dives. Fill in the blanks:

**Planner - 0.7 ATA $O_2$ in $N_2$ - Decompression**

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 1. 60/120 | 20/05<br>10/05 | 10 |
| 2. 100/60 | 30/05<br>10/20 | 25 |

**OBSERVATIONS:**

- Compared with Volume 2, the Dive Planner generally gives shorter, less conservative decompression schedules for 0.7 ATA $O_2$ in $N_2$ dives.

- Recall that on dives with segments breathing a 0.7 ATA $O_2$ in $N_2$ mix at depths greater than 60 fsw there exists a very limited number of experimental dives in the data banks of the model. Therefore, for dives breathing a 0.7 ATA $O_2$ in $N_2$ mix at depths greater than 60 fsw the Dive Planner will give less well-tested decompression schedules that are probably less safe than the Volume 2 schedules.

6. Using the Dive Planner enter the following dive segment: Depth of 190 fsw and a Bottom Time of 50 min, while breathing air.

At this point, note the air TDT from the upper (air) line. Write down the recommended stops at this point in the dive:

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 190/50 | 80/05 | 785 |
| | 70/05 | |
| | 60/10 | |
| | 50/25 | |
| | 40/30 | |
| | 30/45 | |
| | 20/185 | |
| | 10/480 | |

Next, simulate the diver's ascent to the surface by entering a depth of 0, a time of 0, and setting the "follow" option to "Y".

After surfacing, review the dive profile by using the F6 key. Record this final decompression schedule below:

| Depth (fsw)/BT (min) | Rec'ded stops (fsw/min) | Total Stop Time (min) |
|---|---|---|
| 190/50 | 80/05 | 600 |
| | 70/05 | |
| | 60/10 | |
| | 50/25 | |
| | 40/30 | |
| | 30/30 | |
| | 20/170 | |
| | 10/325 | |

**OBSERVATIONS** (please note why this change in decompression schedules occurs, and which schedule you would recommend to the dive supervisor for the actual diver's decompression):

- The change in the decompression schedules occurs because of the concept of conditional probability.

- The correct schedule to recommend to the dive supervisor is the final decompression schedule (in this case with a TST of 600 min).

- Note that this is considered an exceptional exposure dive by the current Volume 1, and with this decompression schedule may be very impractical to accomplish.

**SCENARIO** - DDS HANGAR CREW

1. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The DDS hangar crew must launch and recover the SDV. They will be doing the following dive profile on air: 40 fsw for 2 h (launch SDV) - 0 fsw for 2 h (surface interval) - 40 fsw for 2 h (recover SDV). Plan the dive schedule using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates that the residual nitrogen time from the first dive is 73 min, making the second (repet) dive a No-D dive.

CSMD indicates that this is a No-D dive.

Dive Planner indicates that this is a dive requiring decompression stops as follows: at 20 fsw for 5 min and 10 fsw 35 min.

**RECOMMENDATIONS:**

You might consider recommending Volume 1 or CSMD in this scenario, because for long "square" dives in the shallow regions, the Dive Planner probably overestimates the risk. For the Dive Planner this translates into shorter No-D limits than the current tables for long shallow dives, which may be overly conservative.

**SCENARIO** - SDV CREW / STANDARD SHIP ATTACK

2. You are the DMO underway on a DDS-capable submarine, in support of NSW DDS/SDV operations. The SDV crew returns from a successful ship attack and reports the following multilevel dive profile:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 29/43 | Air | SDV launch from DDS |
| 18/129 | Air | Transit |
| 21/62 | MK 16 (0.7) | Transit to Target |
| 51/21 | MK 16 (0.7) | Actions on Target |
| 21/60 | MK 16 (0.7) | Transit from Target |
| 16/120 | Air | Transit |
| 31/48 | Air | SDV recovery to DDS |

Calculate the decompression obligation for this dive using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates that this is a 51/483 which would have to be calculated on a 60/720 table. This is an exceptional exposure dive requiring over 4 h of decompression.

CSMD indicates:

| Seg # | Transit/ Excursion | Max Depth (fsw) | Time of Segment (Min) | Decompression Time (min) 30 fsw | 20 fsw | 10 fsw | Shallow Interval (Min) | Ending Repet Group |
|---|---|---|---|---|---|---|---|---|
| 1 | Transit | ≤30 | 234 | ___ | ___ | ___ | ___ | L |
| 2 | Excursion | 51 | 21 | ___ | ___ | 26 | 30 | N |
| 3 | Transit | ≤30 | 180 | ___ | ___ | ___ | ___ | O |
| 4 | Excursion | 31 | 48 | ___ | ___ | 19 | 30 | Z |

Dive Planner indicates that this is a No-D dive.

**RECOMMENDATIONS:**

Both the Dive Planner and CSMD give reasonable answers. The difference is probably that the Dive Planner gives you "credit" for using the MK 16, and uses precise depths and times instead of requiring the use of the next deeper or longer table.

The decompression schedule in Volume 1 is not reasonable.

**SCENARIO** - SDV CREW / DEEP LAUNCH & RECOVERY

3. You are the DMO underway on a DDS-capable submarine, in support of NSW DDS/SDV operations. The SDV crew returns after the following multilevel dive and ship attack, with a deep launch and recovery:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 100/40 | Air | SDV launch from DDS |
| 20/120 | MK 16 (0.7) | Transit |
| 50/20 | MK 16 (0.7) | Actions on Target |
| 20/120 | MK 16 (0.7) | Transit |
| 100/40 | Air | SDV recovery to DDS |

They report that both of their gas switches occurred at 20 fsw. That is, they stayed on air during their launch phase until arriving at 20 fsw, and for their recovery phase they switched back to air just prior to leaving 20 fsw.

Volume 1 indicates that this is a 100-fsw/340-min dive, which would have to be calculated on a 100-fsw/360-min table. This is an exceptional exposure dive requiring over 7 h of decompression.

CSMD indicates:

| Seg # | Transit/ Excursion | Max Depth (fsw) | Time of Segment (Min) | Decompression Time (min) 30 fsw | 20 fsw | 10 fsw | Shallow Interval (Min) | Ending Repet Group |
|---|---|---|---|---|---|---|---|---|
| 1 | Excursion | 100 | 40 | — | — | 15 | 30 | K |
| 2 | Transit | <30 | 120 | — | — | — | — | N |
| 3 | Excursion | 50 | 20 | — | — | 29 | 30 | O |
| 4 | Transit | <30 | 120 | — | — | — | — | O |
| 5 | Excursion | 100 | 40 | 10 | 34 | 72 | 30 | Z |

Dive Planner indicates:

After the entire dive profile the Dive Planner recommends the following decompression schedule on air: 40 fsw/5 min, 30 fsw/5 min, 20 fsw/5 min, and 10 fsw/90 min.

For this same dive profile the Dive Planner recommends the following final decompression schedule on the MK 16: 20 fsw/5 min and 10 fsw/20 min.

**RECOMMENDATIONS:**

Note that the CSMD decompression schedule involves 116 min of total stop time (along with a 30-minute shallow water interval), while the Dive Planner's decompression schedule on air involves 105 min of total stop time - both are very similar. Both methods offer reasonable decompression schedules for the divers.

Note that the decompression schedule can be significantly shortened by following the Dive Planner's MK 16 decompression schedule - the total stop time is 25 min. Recall that the MK 16 decompression schedule is thought to be generally less conservative than the air decompression schedule. Therefore, while this schedule may be used to expedite decompression, it may involve taking a greater risk of DCS.

Note that the Dive Planner calls for two brief decompression stops at 40 fsw/5 min and 30 fsw/5 min after the initial launch/excursion to 100 fsw/40 min. These stops may be anticipated by the DMO during the pre-mission planning stages, and communicated to the SDV crew so that they can actually make these "stops" (although the SDV may actually be transiting at these depths) during their dive.

However, even if these stops are not taken by the SDV crew, the Dive Planner will keep track of these "missed stops" and take them into account in calculating the final decompression schedule. As long as the final decompression schedule of the Dive Planner is followed, then this is not a case of omitted decompression.

The decompression schedule in Volume 1 is not reasonable.

**SCENARIO** - DRY DECOMPRESSION PROCEDURE USING OXYGEN

4. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV crew has just completed the same dive as before ( see Scenario 3) except on air only. The exact dive profile is as follows:

| Depth(fsw)/BT(min) | Breathing Gas | Comment |
|---|---|---|
| 100/40 | Air | SDV launch from DDS |
| 20/120 | Air | Transit |
| 50/20 | Air | Actions on Target |
| 20/120 | Air | Transit |
| 100/40 | Air | SDV recovery to DDS |

As the DDS hangar door closes there is an urgent request from the hangar to stop. The operator in the bubble then communicates that one of the SDV operator's has his foot trapped in the door and that it is bleeding profusely. His foot is cleared from the doorway and the hangar door finally closes. You are unsure of the exact medical situation, but you realize that you must expedite decompression.

Plan this dive's decompression obligation as quickly as possible using Volume 1, CSMD, and the Dive Planner.

Volume 1 indicates the same schedule as calculated in Scenario 3 (above).

CSMD indicates the same schedule as calculated in Scenario 3 (above).

Dive Planner indicates: After the entire dive profile, and after arriving at 40 fsw to begin the decompression stops, it recommends an air TDT of 350 min. As there exists a significant medical concern that warrants expediting decompression, the dry decompression procedure using $O_2$ should be utilized (in conjunction with the Dive Planner) to calculate an expedited decompression schedule.

Once at 40 fsw inside the DDS hangar, the injured SDV crew member should be transferred to the dry hyperbaric chamber (while at depth), and placed on 100% $O_2$ via the BIBS mask. Recall that the diver will remain in the chamber at 40 fsw on 100% $O_2$ (25 min. on $O_2$ and 5 min. on air) for a time determined by "$O_2$ Time" ($O_2$ Time = Air TDT ÷ 5 if the Dive Planner air TDT is more than 125 min.). Therefore, his decompression schedule using this procedure should be as follows:

$O_2$ Time = Air TDT ÷ 5

$O_2$ Time = 340 ÷ 5 = 68 min

| Depth (fsw) | Time (min) | Gas |
|---|---|---|
| 40 | 25 | 100% $O_2$ |
| 40 | 05 | Air |
| 40 | 25 | 100% $O_2$ |
| 40 | 05 | Air |
| 40 | 18 | 100% $O_2$ |

**RECOMMENDATIONS:**

First, note the difference (between Scenarios 3 and 4) in the decompression obligation (105 min vs 340 min) that the Dive Planner recommends if the entire dive was done on air only.

In the previous example the transit to the target (20 fsw/120 min), the actions on the target (50 fsw/20 min), and the transit from the target (20 fsw/120 min) were all done on the MK 16. This significantly shortens the Dive Planner's recommended decompression schedule at the end of the dive (as compared to using air during those segments).

Also note that the CSMD decompression schedule does not change based upon the breathing gas used (as the CSMD is actually calculated as if the entire dive was done on air, even if the MK 16 was utilized).

In this scenario, however, because there is a medical urgency (a probably partially amputated foot) that warrants expediting decompression, probably the best course of action is to use the dry decompression procedure using $O_2$ (in conjunction with the Dive Planner) This procedure has the following advantages:

1. It removes the injured diver from the water-filled DDS hangar as quickly and safely as possible.

2. It allows decompression to be accomplished in the more controlled surroundings of the hyperbaric chamber, where medical care may be given to his injured foot (e.g., an I.V. could be started, and direct pressure/bandaging applied to the wound).

3. It actually shortens the decompression time when compared to CSMD. This procedure calls for 78 min of TDT, while CSMD calls for 116 min.

4. It allows the delivery of an increased partial pressure of oxygen that may help the injured diver avoid shock, have better wound healing, and maybe even save a partially amputated appendage.

**SCENARIO** - UNEXPECTED DEPTH EXCURSION

5. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SDV Task Unit onboard is in the beginning stages of their pre-deployment work-up and is practicing SDV launches and recoveries from the DDS. There are 12 men on the dive (this includes the hangar crew and the SDV operators) and everyone is breathing air. All have been working for the past 116 min between 30 and 40 fsw, when the submarine loses depth control. The submarine dives to exactly 70 fsw (the greatest depth for the divers), where it levels off for 4 min. It then loses depth control again, going straight to the surface. The commanding officer tells his conning officer to come to "all stop" and keep the submarine on the surface in order to accurately assess the situation.

The dive supervisor immediately communicates with the men in the DDS. He confirms a head count of 12 men and that there are no injuries to report: everyone feels fine and is asymptomatic for either DCS or A.G.E. In fact, they report enjoying the hot sunshine on the deck of the submarine.

But the DDS dive supervisor is concerned. He turns to you and states, "I think we have 12 divers with omitted decompression, what should we do?"

You begin to calculate these divers' decompression obligation using Volume 1, CSMD, and the Dive Planner.

**Volume 1 indicates** that this is a 70-fsw/120-min dive profile, requiring the following decompression stops: 20 fsw/4 min and 10 fsw/47 min. Therefore, Volume 1 indicates that these divers have 51 min of omitted decompression.

**CSMD indicates** essentially the same answer as Volume 1, because any descent greater than 30 fsw must be treated as a single excursion. Therefore, this dive profile must be calculated on a 70-fsw/120-min schedule.

**Dive Planner indicates** that this dive (40 fsw/116 min and 70 fsw/4 min) is a No-D dive.

**RECOMMENDATIONS:**

Probably the Dive Planner gives the best recommendation in this situation. Remember that the other methods of calculating decompression (i.e., Volume 1 and CSMD are forced to "round-off" on this dive profile. Therefore, they must treat this dive as a "square" dive of 70fsw/120 min, when only 4 min were actually spent at 70 fsw.

Treatments in the DDS hyperbaric chamber should not be taken lightly, for the following reasons:

1. This chamber has minimal environmental controls.
2. This chamber has only 6 BIBS masks (impossible to treat all 12 divers at once).
3. This chamber has only a limited supply of $O_2$, that can only be replenished by cancelling diving operations, returning to port, and recharging the $O_2$ cylinders.

Therefore, on this "hot day" (with 12 asymptomatic divers with potentially omitted decompression) and with the known limitations of the DDS hyperbaric chamber, probably the best course of action is the following:

1. Follow the Dive Planner's recommendation and consider this a No-D dive (but recognize that it is right at the No-D limit).
2. Recommend cancelling the remaining diving operations for that day.
3. Carefully exam each diver for any symptoms/signs of decompression illness, and if completely normal, then observe the divers closely for 12-18 h.
4. Treat any diver if they present with any symptoms/signs of decompression illness.

**SCENARIO-** "SAVE THE TENDER"

6. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. A U.S. Marine Corps forced reconnaissance unit is onboard the sub for some training with the SDV task unit. They are planning a USMC and SDV Mass Swimmer Lock-Out. At periscope depth, the divers will lock-out 2 small inflatable rubber boats, 2 outboard motors, fuel, and operational equipment. Five SEALS and 5 Marines will lock-out, each breathing air from a single-80 SCUBA cylinder.

During the operation, however, one of the Marines gets entangled in the ascent line with the buoy. He panics and mistakenly inflates the buoy. This causes him to ascend rapidly to the surface and he forgets to exhale all the way from 40 fsw to the surface.

On the surface, he is unconscious with blood coming from his mouth. One of the SEALS activates his lifejacket, opens his airway, and signals the submarine to surface, as he has a medical emergency during this training exercise. You diagnose an A.G.E. through the periscope and tell your best diving medical technician to prepare for an aggressive treatment table.

A MK 20 AGA full face mask is placed over the stricken diver's face. His airway is opened, his lifejacket deflated, and he is swum into the DDS complex for treatment.

You confirm that a pulse is present as the stricken marine enters the treatment chamber and you compress the chamber to 60 fsw at 25 fpm. After 15 min at 60 fsw the corpsman reports that the marine is deteriorating - his pulse has become irregular and his systolic BP has dropped from 100 to 60. You decide to go to 165 fsw on air. Initially, the marine improves and then, without warning, he becomes pulseless, and apneic. The corpsman performs CPR, gives fluid boluses, and ACLS medications at your direction. But, after 30 min of CPR the marine remains pulseless. You pronounce him dead and begin to discuss the series of events with the commanding officer of the submarine.

The dive supervisor correctly interrupts your conversation and says "We still have to get the tender out of there! He was at 60 feet of seawater for 15 min and then 165 feet of seawater for 40 minutes. According to the U.S. Navy Dive Manual he needs to come out on a Treatment Table 4 (TT4), and that takes 36 hours and 41 minutes. Is there any way to get him out faster and still safely?"

You realize that the dive supervisor is exactly right - because you went past 30 min at 165 fsw, the Volume 1 of the Dive Manual now calls for a TT4. You begin to calculate your options for safely decompressing this tender. You consider using Volume 1, CSMD, and the Dive Planner.

**<u>Volume 1 indicates</u>** that this dive could have the following profile and stops:

| Dive Profile Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 170/60 | 50/02 | Air | **150** | This Vol.1 schedule is just one short of an exceptional exp. dive. |
| | 40/15 | | | |
| | 30/22 | | | |
| | 20/37 | | | |
| | 10/74 | | | |

**<u>CSMD</u>** is not approved for use at depths greater than 120 fsw.

**<u>Dive Planner indicates</u>** that this dive (60 fsw/15 min and 165 fsw/40 min) profile's decompression schedule may be expedited using the dry decompression procedure using $O_2$ as follows:

| Depth (fsw) | Time (min) | Gas |
|---|---|---|
| 60 | 05 | Air |
| 50 | 20 | Air |
| 40 | 25 | 100% $O_2$ |
| 40 | 05 | Air |
| 40 | 25 | 100% $O_2$ |
| 40 | 05 | Air |
| 40 | 25 | 100% $O_2$ |

Note: The total stop time for this decompression schedule is 110 min (75 min of which is on $O_2$).

**<u>RECOMMENDATIONS:</u>**

Altering treatment tables should never be done casually. However, in this scenario the patient has expired, and now the real problem is how to best decompress the tender in a safe and timely manner. In one sense this scenario could be viewed as a deep multilevel chamber dive on air. However, the risk of DCS that one is willing to take while diving should probably be greater than the risk one should have to take while tending. Therefore, while the dry decompression procedure using $O_2$ offers perhaps the best method of expediting decompression in this scenario, it may still take a greater risk than one would recommend for an Inside Tender. Ultimately, the situation will dictate the best course of action for the DMO/dive supervisor.

**In summary, the Dive Planner represents an excellent tool in calculating the decompression obligation for an inside tender doing a non-standard treatment table.**

As always the DMO is encouraged to contact NMRI (at 301-295-5875/1839) or NEDU (at 904-230-3100) 24 h a day for any diving/decompression-related questions.

**SCENARIO-** SAFELY MAXIMIZING BOTTOM TIME AND MINIMIZING DECOMP.

7. You are the DMO underway on a DDS-capable submarine in support of NSW DDS/SDV operations. The SEAL officer-in-charge comes to you and says, "I can't tell you much, but I need to do an operation at 150 feet of seawater for 40 minutes. I can breath air on the MK 16 or switch back and forth at almost any time during the operation. I want you to tell me how I can safely maximize my bottom time and minimize my decompression time."

You begin to calculate the options using Volume and 2, CSMD, and the Dive Planner. You come up with the following:

**Volume 1 indicates** that this dive could have the following profile and stops:

Dive Profile

| Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 150/40 | 30/05<br>20/19<br>10/33 | Air | **57** | Vol. 1 |

**Volume 2 indicates** that this dive could have the following profile and stops:

Dive Profile

| Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 150/40 | 50/07<br>40/15<br>30/19<br>20/28<br>10/28 | MK16 | **97** | Vol. 2 |

**CSMD** is not approved for use at depths greater than 120 fsw.

**Dive Planner indicates** that this dive could be done one of three ways depending on the breathing gas / switching breathing gases:

1\. Dive Profile

| Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 150/40 | 50/05<br>40/10<br>30/25<br>20/35<br>10/75 | Air | **150** | Planner |

2\. Dive Profile

| Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 150/40 | 40/05<br>20/05<br>10/55 | MK16 | **65** | Planner |

3\. Dive Profile

| Depth/BT (fsw)/(min) | Rec'd stops (fsw/min) | Gas | Total stop Time (min) | Comments |
|---|---|---|---|---|
| 150/40 | 40/05<br>20/05<br>10/30 | Air/<br>MK 16 | **40** | All BT on Air then switch to MK 16 for decompression |

**RECOMMENDATIONS:**

The following basic principles should be kept in mind when trying to safely maximize bottom time and minimize decompression time, while breathing air and/or MK 16:

1. At 77 fsw, while breathing compressed air, the ppO2 is 0.7 ATA.
2. Deeper than 77 fsw, while breathing compressed air the ppO2 is > 0.7 ATA.
3. Therefore, there is less of a $N_2$ burden while breathing air at > 77 fsw than breathing the MK 16.
4. Therefore, in order to maximize BT and minimize decompression time, the best combination is to breath air at > 77 fsw and the MK 16 at < 77fsw.

This is a classic example of the Dive Planner's great flexibility at planning dives, and its strength at planning nitrox dives, possibly involving gas switching.

In this scenario, the DMO should probably present all of these options to the DDS dive supervisor and SEAL officer-in-charge and allow them to make the final decision, based upon mission requirements/constraints.

# APPENDIX C

# DIVE - V6.0

# REAL TIME DIVE PLANNER USER'S MANUAL

# DIVE-V6.0

## Real Time Dive Planner User's Manual

**For Naval Special Warfare use only**



April 1996

## Real Time Dive Planner

# DIVE-V6.0



**Release Notes for NMRI Dive Planner V6**

Below are the new features added to the Dive Planner since the release of the last version (V5.1c).

1. V6 allows separate simultaneous runs of the dive planner under Windows from the "Dive Planner V6" group window with five icons.

2. At the beginning of a dive, the user can now enter the diver's Exit State (A-Z) from the end of his last dive, and the time elapsed since the last dive (surface interval).

The state and surface interval entered here are used to calculate the diver's repetitive state for the current dive plan. (In V5.1c, the diver was assumed to be "clean", that is, in repetitive state 'A')

**The repetitive states used by the dive planner are not compatible with Vol. 1 repet groups! Do not use a repet group from a USN standard air dive in the Dive Planner.**
**Do not use Dive Planner repet states for calculating repet group in Vol. 1.**

3. A repetitive State and surface interval can be entered for all of the divers that will be going on the same dive mission. Since the divers may be in different repetitive States, the dive planner will calculate the current simulation for all divers in the group based on the diver with the "worst case" repetitive state.

4. The diver's Exit State (A-Z) is displayed at the end of a dive and saved in the summary file.

5. The update interval for simulating a dive is 10 sec throughout the dive. In V6 the surface interval is updated all at once rather than in 10 sec intervals. This speeds up the simulation of repetitive dives with long surface intervals.

The simulation uses Air as the breathing gas during surface intervals even if the user indicates Gas 2.

6. The user is automatically prompted for a file name at the end of a simulation so that the dive's information (time-depth profile, gas mixes used, repetitive state) can be saved. In V5.1c the user had to execute a Save command from the File menu to save the last simulation.

7. A single comment line (up to 59 characters) describing the dive can be entered at the time of saving the dive scenario. This allows the user to make notations which will be included in the Dive Summary file for later reference.

8. The comment line described above will be displayed along with the file name when listing file names in the **Use**, **Print**, **Delete** and **View** commands from the **File** menu. This will aid in selecting the proper file by giving more information than can be contained in the 8 character file name itself.

9. After executing the **Use** command, the planner will automatically enter the Run mode with the chosen dive scenario (from the file selected) as the default scenario.

10. In the event that your computer "crashes", either due to a power failure or for any other reason, while you are running the dive planner, you will have to run a clean-up program before running the dive planner again. To accomplish the clean-up, simply double-click on the icon for any copy that was running at the time of the crash. A message screen will appear with specific instructions to clean up that copy of the dive planner. Simply follow the instructions as presented and you will be able to run that copy again. This applies only to those copies that were running at the time of the crash. In fact, only those copies affected will give the clean-up instruction message, other copies will run normally.

**Real Time Dive Planner**

# DIVE-V6.0



## Introduction

The probabilistic decompression model USN-93 was developed and calibrated using a large data base consisting of well documented air and nitrox dives with known outcome of DCS. A real time algorithm using the USN-93 model was developed and validated with a large dive trial using chambers. A large fraction of the validation series were typical Specwar dives with multilevel profiles, gas switching between air and 0.7 $PO_2$ in $N_2$ and long shallow transits. The **Dive Planner** uses the same algorithm to compute decompression schedules at every 10 second interval of the dive being simulated.

The **Dive Planner** is designed for planning a dive using air or an underwater breathing apparatus (UBA) with 0.7 absolute atmospheres (ATA) $O_2$ in $N_2$. Diver's depth, bottom time, travel rate, etc. are entered interactively for each segment of the dive. The Dive Planner computes a decompression schedule as the dive progress is simulated. The dive can be as simple as a single bounce dive or a complicated multilevel dive with breathing gas being switched between air and the 0.7 $O_2/N_2$ mix. At the end of all the dive segments representing the diver's depth-time-gas profile, the user can simulate the diver's ascent to the surface by following the calculated decompression schedule. This last step of simulating the diver's ascent to the surface is necessary because the actual decompression profile may change during the ascent. A summary of the planned dive can be printed for record keeping and approval.

*************************************************************************

**Note:**
**All planned Exceptional Exposure (EE) dives need prior CNO approval.**
**EE dives are defined as follows:**

**Air dives to greater than 190 feet of seawater equivalent (fsw).**
**Dives with UBA (0.7 ATA $O_2$ in $N_2$) to greater than 150 fsw.**

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# Installation

1) Start your computer in Windows. (Windows 3.1 or 3.11 only, this Installation is not valid for Win95 or network versions of Windows)

2) Insert the Dive Planner V6.0 floppy disk into the disk drive.

3) Click on the **File** menu at the upper left of the Windows Program Manager.

4) Click on **Run** from this menu.

5) In the dialog box which appears, type either:

| | | |
|---|---|---|
| | **a:installa** | if your floppy drive is drive a: |
| or | | |
| | **b:installb** | if your floppy drive is drive b: |

6) The dive planner will take about 1 minute to install on your computer. The directory \RDMV6, as well as several subdirectories, will be created on your C: drive. The entire installation takes up less than 1.5 MBytes.

7) At the end of the installation a screen will appear with the message: **Restart Windows now!**

8) Press any key to clear this message and return to Windows, then...

9) Exit Windows by clicking on the **File** menu at the upper left and on **Exit Windows...** from this menu.

10) Now restart Windows by typing **win** at the C:\ prompt, or simply reboot (power off then power on) the computer.

11) When Windows starts this time there will be a new group of icons for the Dive Planner V6 with the labels; Trunk-1, SDV Crew-1, Chamber-1, Hanger-1 and Mission Spec-1.

## Running

There are five copies of the Dive Planner program in the Dive Planner V6 group, each with its own icon and title: Trunk-1, SDV Crew-1, Chamber-1, Hanger-1 and Mission Spec-1.

All five copies are identical except for these labels. They all run the same Dive Planner program and each can be used to plan any type of dive. These labels are provided for ease of keeping track of several dive exposures.

To run the Dive Planner, double-click on any one of the five icons in the Dive Planner V6 group. If you intend to plan a dive for the SDV Crew, you should double-click on the icon with that label so you can identify this copy later.

You can run more than one Dive Planner copy at one time. This allows you to keep track of several dive exposures simultaneously.

To run a second copy of the program press **Alt-Tab** (hold down the Alt key and tap the Tab key once) to return to Windows. Now, double-click on another Dive Planner copy's icon.

You can use **Alt-Tab** to rotate between all programs you have running in Windows (including Windows Program Manager itself) by holding down the Alt key and repeatedly pressing the Tab key. At each press of the Tab key, a small window will appear with the label of a running program in it. Continue pressing Tab until the program you want to resume appears in the box, then let up the Alt key.

An alternative method of moving between copies of running programs is to press **Ctrl-Esc** (hold down the Ctrl key and press the Esc key). A window will appear with a list of all programs currently running. Simply select the program you want to resume from this list.

Depending on your computer's system resources, you can run each of the five copies of the program at once to keep track of up to five dive scenarios. However, you cannot restart a copy while it is already running. For example, you can have the Trunk-1, Chamber-1 and Hanger-1 copies all running simultaneously, but you cannot have two Hanger-1 copies running at once. If you attempt to restart an already running copy an error message will appear.

Limited system resources could restrict the number of copies of the program that can be run at once. If you get a Windows error message indicating a low memory condition, exit (use **Esc** key or **File** and **Exit**) from one or more of the Dive Planner copies and continue running the other copies.

Low memory conditions may cause unpredictable Windows graphics errors, especially when using **Alt-Tab** to move from one copy to another. These graphics errors occur in Windows and not the Dive Planner so they do not adversely effect the results calculated by the Dive Planner, that is, the answers given are correct even if the screen has an odd appearance.

The Dive Planner program shows two commands on the main menu: **File** and **Run**.
Use right or left arrow keys to highlight the either of these commands and press the Enter key to execute the command.

The **Run** command will be explained first.

The **File** command will be explained later.

**Run** command from the main menu:

Highlight the **Run** command and press the Enter key.

The first screen you see allows you to enter the Repetitive State (A-Z; upper or lower case allowed) and surface interval for each diver participating in this planned dive. Enter the diver's Exit State from his previous dive **(Dive Planner Repet States ONLY ! Do Not use Vol. 1 Repet Groups !)** and the time elapsed since surfacing from that dive in hours alone or as hours and minutes (HH:MM). For example, a three hour surface interval can be entered either as 3 or as 3:00, and a three hours and 15 minutes surface interval is entered as 3:15. A "clean" diver is in state 'A'. Use the **F2** key to add divers to the list and **F3** to remove them. Press the **F5** key when you finish entering these values. One profile will be calculated for all divers on the list, based on the "worst case" repetitive state among them.

The box on the upper right corner of the screen is used to give information about the current dive segment to the program: what depth the diver will be going to next, how long the diver will stay at that depth, if the diver is going to change the gas mix at that time, etc. The diver status (the diver's current depth, time, gasmix) are displayed in the lower right corner and the decompression schedule information is displayed to the left of the diver status, and is updated as the dive progresses.

The following rules apply for entering the information about any dive segment. Just pressing the Enter key will keep the field unchanged and the cursor will move to the next field. Tab and down-arrow ↓ keys have the same effect. Shift-Tab and up-arrow ↑ keys move the cursor one field upward. If you want to change a field, move to that field by pressing Enter, Tab, shift-Tab, ↑ or ↓ and enter a new value. You can change the fields multiple times. Once all the fields are set to desired values, press F5 to start that segment of the dive. Pressing F4 allows the user to go one dive segment backward, effectively deleting the last segment of the dive and to re-start at that point. If you press the F6 key at any time during the dive segment entry, a box with a depth-time history of the dive progress will appear in the upper right corner and will remain on the screen until any key is pressed. An asterisk in the dive history denotes that the corresponding time was spent using 0.7 $O_2/N_2$ mix. Note that the dive history is only approximate, a detailed accurate outline can be obtained from a summary file as explained later.

You can exit the program by pressing the Escape key at any time. The Escape key will finish the dive scenario and display the depth-time history, which will remain on the screen until any key is pressed. Use of the Escape key is a normal way to finish a dive scenario. You will be prompted for a file name to save the dive scenario. If you wish to save this dive, enter a file name (up to 8 characters). After entering the file name, you will be prompted for a one line (59 characters) description of the dive. Use this space to make descriptive comments about this dive for

later reference. If you do not want to save this dive, hit the ESC key to return to the main menu screen.

Note that it is better to use the F6 key to examine the dive history before pressing the escape key to end the dive. Once the escape key is pressed, you cannot backup into the dive using the F4 key.

Each dive segment consists of the following fields which can be changed by the user.

Field definitions:

**Depth(fsw)**: Enter a destination depth in a range of 0 to 300 fsw. If the diver is already at a specific depth (displayed at lower right corner) and wishes to remain there longer, the current depth must be given as the destination depth. If the depth entered is deeper than the normal operation depth, a message "CNO approval required" will appear on the screen and the depth will be marked as "TOO DEEP" in the summary file.

**Time At Depth**: Enter time (min) to be spent at the destination depth. The travel time is counted as part of time at depth when going deeper but not counted when going shallower. If the travel time is greater than the time at depth, then the travel time is not counted as the part of the time at depth. For example, a value of zero means just travel to the destination depth.

Negative time has a special meaning in the Dive Planner. -999 or a larger negative number means spend all of the possible No-D time at the destination depth. Smaller negative numbers have a different meaning. For example -5 means, stay at the destination until 5 minutes of No-D time is left.

**Gas Mix No.**: If you want to change gas mix at this time enter new gas mix number 1 or 2. A value of 1 indicates air while value of 2 indicates 0.7 $O_2/N_2$. The current gas mix being used is displayed at the lower right corner.

**Travel Rate**: Enter rate of travel to the destination depth (fsw/min). This rate is used even when following a decompression schedule. (The printed tables are computed with the travel rate of 60 fsw/min).

**Follow(Y/N)**: Enter **Y** (Yes) or **N** (No). **Y** means the diver wishes to follow the Planner's advice to the destination depth, taking intermediate stops if needed. **N** means the diver is not following the Planner but wishes to travel to the destination depth ignoring the Planner's advice.

If the user is entering previously known depth-time segments, this field must be set to **N** because these segments of the dive were already conducted without the Planner's advice. At the end of all

known dive segments, the user should set this field to **Y** with a destination depth of zero fsw, to simulate the diver's ascent to the surface, following the Planner's advice.

If (inadvertently) the **Follow** field is set to **N** during the last segment of the dive, and decompression is omitted, pressing the F6 key will display a dive history where the **Risk** field will have an exclamation point instead of a value. This indicates that the dive was improperly ended. In such a case, you may use the F4 key to back up to the previous segment and change the **Follow** field setting to a **Y**. Note that it is preferable to use the F6 key to examine the dive history and to ensure that **Risk** is displayed before using the escape key to end the dive. Once the escape key is pressed, you cannot back up into previous segments of the dive.

*******************************************************************************

**Note:**
**When entering known segments of the dive profile, where the "Follow" field is set to "N", the dive planner will allow the user to input shallow segments (including surface intervals) of the dive, even if the planner computes an in-water decompression obligation. If a surface interval occurs as a part of a planned profile, or was operationally required during the actual profile, the user should input air as the breathing gas mix during the surface interval even if another breathing mix was actually used. The algorithm used to compute the decompression profile is not validated for breathing mixes other than air during a surface interval.**

*******************************************************************************

When all of the above fields are set to the desired values, press F5 to start that segment of the dive. When F5 is pressed, the dive is simulated at every 10 second (sec) interval of the dive and the diver status and the computed decompression schedules are displayed in the lower portion of the screen. At the end of each dive segment, a graphical plot of the dive progress is displayed on the screen. The graph represents the diver's depth-time-gas history since the beginning of the dive. Remaining No-D time, if greater than zero, is also displayed at the end of each dive segment.

Pressing F4 will delete the last segment of the dive.

Pressing F6 will cause the depth-time history of the dive to appear on the screen. Press any key to erase the dive history and to get back to entering the dive segment.

**The display consists of the following fields:**

**Depth**: Diver's current depth in fsw.

**Time**: Total elapsed time in minutes since the start of the dive.

**Gas**: Diver's current breathing gas mix. The current gas mix is also highlighted in the gas definition legend.

**TDT**: Total Decompression Time (a sum of all stop times) in minutes. Note that the TDT does not include travel time.

The stop times at each stop depth (from 100 fsw to 10 fsw) for the two decompression profiles, one for each gas, are also displayed. Note that the stop times and the TDT may change as the diver ascends to the surface.

**NOD Time**: Remaining No-D time in minutes, if greater than zero, at this depth. This field is displayed only at the end of each dive segment and only if the TDT for the current gas is zero.

**Risk**: The diver's total risk of DCS from the dive.
This field, denoting the diver's total risk, is displayed at the bottom of the depth-time history when F6 is pressed or when the dive is ended with the escape key. This field will not appear as a part of the dive history if the diver is still at depth. An exclamation point in this field indicates that the dive is improperly ended, i.e., the diver has omitted decompression stops. In such a case, the summary file will also reflect that the dive was improperly ended. As explained earlier, use the F6 key to examine the dive history before ending the dive with the escape key. If the **Risk** field has an exclamation point at the end of the dive, it is likely that the user has attempted to omit decompression by not following the planner to the surface. Back up to the previous segment, using the F4 key, and set the **Follow** field to **Y** for the last segment to correctly simulate decompression to the surface.

If decompression was omitted during the known segments of the dive profile, the planner will still compute a decompression schedule. For a dive profile where a diver is on the surface and decompression was omitted, the dive history will display an exclamation point instead of a value for **Risk**. This should signal to the user that decompression was omitted. The last segment of any profile should have the **Follow** field set to **Y** in order to compute a safe decompression profile to the surface.

**File** command from the main menu:

Highlight the **File** command and press the Enter key.

This command offers several options. Highlight the desired option and press the Enter key. The Escape key will bring back the main menu. The options are as follows:

**Use**
**Save**
**Delete**
**View**
**Print**
**Dos Shell**
**Exit**

**Use**: This option allows you to use an existing (previously **Saved**) dive scenario as the starting environment. A list of dive scenarios that currently exist on the disk is displayed on the screen. The user can highlight the desired name by using ↑ ↓ keys and press the Enter key to **Use** that file. If you want to make a slight variation to a previously existing dive scenario, you can execute the **Use** option first, then **Run** the Dive Planner and make the appropriate changes in the dive segments.

**Save**: This option saves the results (the dive scenario) of the previous **Run** of the Dive Planner under a user specified name. Enter a file name (up to 8 characters) when prompted. After entering the file name, you will be prompted for a one line (60 characters) description of the dive. Use this space to make descriptive comments about this dive for later reference. You cannot write over an already existing scenario. If you wish to replace an old scenario with the new one under the same name, **Delete** the old scenario first and then **Save** using the same name.

**Delete**: This option allows the user to delete previously saved dive scenarios. This option is useful for cleaning up the directory.

**View**: This option allows the user to view any existing dive summary. A dive summary is a text file with all the information about a specific run. The dive summary is displayed on the screen via the DOS editor, thus all editor commands are valid (see your DOS manual). The command sequence Alt-F, X will get you out of the View option and back to the main menu. You cannot save any changes made to this file (knowingly or unknowingly) while viewing it.

The time, depth and gas information given in this file is more precise than the dive history displayed on the screen at the end of the Dive Planner run. The summary file will mark a depth as "TOO DEEP" if the planned dive is deeper than the normal operation depth and will indicate that CNO approval is needed. (If you simulate a deep segment and then use F4 key to delete that

segment, the message "CNO approval needed" will erroneously remain in the summary file. It will also mark the depths as "TOO SHALLOW" if the diver goes shallower than the deepest recommended stop at any time. Indication of an improperly ended dive will also appear if the dive is ended (with an Escape key) while the diver is still at depth, or if the diver surfaces too soon, omitting decompression stops. A properly completed dive summary will show the diver being on the surface for another 24 hours and also show the diver's total risk of DCS from the dive. This file can be printed using the **Print** option.

**Print**: This option allows the user to print any of the existing dive summaries. The **View** option from the **File** command can be used to view the summary before printing it. The printed hard copy of the dive summary can be used for official approval process and record keeping. The dive summaries are kept as read-only files so that they can be protected from inadvertent changes. If the dive planner computer does not have access to a printer, the summary file (with extension .SUM) can be copied to a diskette and printed on another computer.

**Dos Shell**: This option allows user to "shell out" to the DOS environment. Remember to enter "exit" to get back to the DIVE program.

**Exit**: This option allows user to exit the DIVE program. Pressing the escape key at any time also allows user to exit respective programs.

## Example

An example is included as a part of the distribution for the Hanger-1 copy of the Dive Planner (double-click on the "Hanger-1" icon). Execute the **Use** option under **File** and choose **EXAMPLE**. Enter F5 to accept the diver repetitive states in the first screen, then subsequent F5 entries to execute each dive segment. Enter F6 between dive segments to display the dive progress to that point. Enter the escape key when the diver finally arrives at surface. For the purposes of this example dive, hit ESC when prompted for a file name. Execute the **Print** or the **View** option from the **File** menu and choose **EXAMPLE** for reviewing the dive summary.

**EXAMPLE**: This example shows a dry deck shelter dive. There are three divers on this mission. The first is a "clean" diver (in State 'A'), the second has done a dive earlier in the day which left him in State 'F' and which surfaced three hours earlier. The third diver surfaced from a dive 17 hours ago in State 'T'.

The divers spend 40 min at 40 fsw on air. Then they switch to the second gas mix (0.7 $O_2/N_2$), and transit for 180 min at 15 fsw. They make an excursion to 60 fsw for 30 min and then transit at 15 fsw for 180 min. They switch back to air and spend 40 min at 40 fsw before returning to surface. Note that the **Follow** field is set to **N** for all but the sixth dive segment. This dive scenario does not require any decompression time. Press the Escape key to end the dive when the diver ascends to the surface after the sixth segment. The summary (from **File** and **View**) will be as follows:

```
Dry deck shelter - 3 divers

Hanger-1 DIVE-V6.0
_______________________ Dive Scenario Summary _________________

__ Dive Gas Mix Parameters ____________________________________

                        Gas Type              Oxygen Amount
    Gas Number    (1=Fraction / 2=ATA)     (Fraction / PO2)
    ----------    --------------------     ----------------
        1                  1                     .21
        2                  2                     .70

__ Diver's States at the End of Their Last Dive ____________

  Diver Number   Exit State     Surface Interval (HH:MM)
  ------------   ----------     ------------------------
       1              a              0: 0
       2              f              3: 0
       3              t             17: 0
```

__ Dive Profile Results ______________________________________

| Time (min) | Depth (fsw) | Gas Mix | Comments |
| --- | --- | --- | --- |
| Starting State: | E | | |
| .00, | .00, | 1, | |
| .67, | 40.00, | 1, | |
| 40.00, | 40.00, | 1, | FSW 40.0 / 40.0 MIN |
| 40.17, | 40.00, | 2, | GAS MIX CHANGED |
| 40.67, | 15.00, | 2, | |
| 220.67, | 15.00, | 2, | FSW 15.0 / 180.0 MIN |
| 221.50, | 60.00, | 2, | |
| 250.67, | 60.00, | 2, | FSW 60.0 / 30.0 MIN |
| 251.50, | 15.00, | 2, | |
| 431.50, | 15.00, | 2, | FSW 15.0 / 180.0 MIN |
| 431.67, | 15.00, | 1, | GAS MIX CHANGED |
| 432.17, | 40.00, | 1, | |
| 471.67, | 40.00, | 1, | FSW 40.0 / 40.0 MIN |
| 472.33, | .00, | 1, | |
| 1912.33, | .00, | 1, | |

Risk .78 %

Exit State: J

---

Note that all divers are now assigned to repetitive state **J** at the end of this dive.

**The repetitive states used by the dive planner are not compatible with Vol. 1 repet groups!**
**Do not use a repet group from a USN standard air dive in the Dive Planner.**
**Do not use Dive Planner repet states for calculating repet group in Vol. 1.**

Please address all comments and questions to **Ms. Shalini Survanshi** at

Tele: (301) 295-5898
Fax: (301) 295-0782

or **LCDR Valaik** at

(301) 295-5776

Naval Medical Research Institute, Code 54
8901 Wisconsin Avenue
Bethesda, MD 20889-5607

In case of an emergency, a NMRI Undersea Medical Officer can be reached through one of the following numbers:

(301) 295-1839
or
(301) 295-5875

# Dry Decompression Procedure Using Oxygen
# For the Real Time Dive Planner.
### For Naval Special Warfare Use Only

**Overview**

This decompression procedure is to be used to shorten the decompression time for air dives by using oxygen in a dry environment. **It is to be used only in conjunction with the Real Time Dive Planner.**

The following summarizes its' use:

1. The SDV and/or Hangar crew divers are decompressed (on air) according to the recommendation of the Dive Planner to the 40 fsw stop while in the hangar.

2. Once at 40 fsw the divers are transferred to the dry Hyperbaric Chamber at depth, and placed on 100% oxygen via the bibs mask.

3. The divers remain in the chamber at 40 fsw on 100% oxygen (25 min. on $O_2$ and 5 min. on air) for a time determined by "$O_2$ Time". The $O_2$ time is calculated as follows:

If Air TDT (as calculated by the NSW Dive Planner) is less than or equal to 125 min: $O_2$ Time = 25 min*

If Air TDT is more than 125 min: $O_2$ Time = Air TDT ÷ 5

*See "Detailed Description" section for explanation of *.

4. Once the required oxygen time is complete, travel to the surface at a rate of 30-60 fpm. Divers come off oxygen upon reaching surface.

**Detailed Description**

The dry decompression procedure using oxygen is a two part process, as follows:

1. Use of the NSW Dive Planner to calculate the decompression stops and the $O_2$ Time needed.
2. Implementation of the decompression procedure for the divers in the water.

**Use of the Dive Planner**

1. Use the Dive Planner to enter the dive segments of the profile representing the depth-time exposure incurred by the divers during the operation, including their arrival and the hold at the DDS hangar.

2. Enter the next segment as below:

Depth (fsw): **40**
Time At Depth: 0
Gas Mix No.: 1
Travel Rate: 60
Follow(Y/N): **Y**

This will simulate the divers' ascent to 40 fsw (or descent if the hanger is shallower than 40 fsw) by following the Dive Planner. This may involve additional deeper stops before getting to 40 fsw. Use the F6 key to **note any required decompression stops needed to get to 40 fsw.**

3. The bottom two lines displayed on the screen at this time provide the TDT and the decompression schedule for the two gas mixes. **Note the <u>Air</u> TDT from the <u>UPPER</u> (air) line**, as it will be used to calculate $O_2$ Time.

4. When oxygen decompression is feasible, use the table below to determine the $O_2$ Time:

| Air TDT (min) | $O_2$ Time (min) | Air TDT (min) | $O_2$ Time (min) |
|---|---|---|---|
| 5- 125 | 25* | 1005-1125 | 225 |
| 130- 250 | 50 | 1130-1250 | 250 |
| 255- 375 | 75 | 1255-1375 | 275 |
| 380- 500 | 100 | 1380-1500 | 300 |
| 505- 625 | 125 | 1505-1625 | 325 |
| 630- 750 | 150 | 1630-1750 | 350 |
| 755- 875 | 175 | 1755-1875 | 375 |
| 880-1000 | 200 | 1880-2000 | 400 |

**Or** calculate $O_2$ Time as below:

If Air TDT is less than or equal to 125 min: $O_2$ Time = 25 min*

If Air TDT is more than 125 min: $O_2$ Time = Air TDT ÷ 5

*In an **emergency** situation when the Air TDT is less than or equal to 125 minutes, and with DMO approval, the initial 25 min of $O_2$ Time may be shortened. In this case the DMO may recommend simply dividing the Air TDT by 5 to compute the $O_2$ Time.

**Implementation**

1. Decompress the divers in the hangar to 40 fsw on air. Take all decompression stops recommended by the Dive Planner until reaching 40 fsw. Use a travel rate between 30 and 60 fpm to reach 40 fsw.

2. Once at 40 fsw, transfer the divers to the dry Hyperbaric Chamber at depth, and place on 100% oxygen via the bibs mask.

3. The divers remain in the chamber at 40 fsw on 100% oxygen (25 min. on $O_2$ and 5 min. of air) for a time determined by "$O_2$ Time" (as calculated above). If Air TDT recommended by the Dive Planner is less than 25 min, the normal air decompression procedure may be used.

4. A 5 min air break must be performed after each 25 minutes of oxygen breathing.

5. All time spent on air is considered dead time and does not count towards $O_2$ Time.

6. Once the required oxygen time is complete, travel to the surface at a rate 30-60 fpm. Divers come off oxygen upon reaching surface.

**Oxygen Interruption**

If oxygen breathing is interrupted either due to mechanical failure or due to CNS oxygen toxicity, count all air time as dead time and resume oxygen breathing at the point of interruption. If oxygen breathing cannot be restored or tolerated, recompute the decompression profile by entering all time spent on oxygen as time spent on 0.7 ata $O_2$ (Gas Mix No.: 2), and all time spent on air at 40 fsw as air time (Gas Mix No.: 1). Follow the **air** decompression schedule to the surface.

Example: Upon arrival to 40 fsw in the chamber, the Air TDT computed by the dive planner is 640 min. Using the dry decompression procedure, divers are obligated to 128 min $O_2$ Time at 40 fsw in the dry hyperbaric chamber. Immediately following the second $O_2$ period, one diver suffers an oxygen convulsion, and thus cannot go back on oxygen. Re-enter the diver's exposure profile up to the 40 fsw oxygen stop.

Enter the segments at 40 fsw as follows:

Depth (fsw): 40
Time At Depth: 25

Gas Mix No.: **2**
Travel Rate: 60
Follow(Y/N): N

(Note: This represents the first 25 min. oxygen breathing period at 40 fsw in the chamber.)
Press F5 Key.

Depth (fsw): 40
Time At Depth: 5
Gas Mix No.: **1**
Travel Rate: 60
Follow(Y/N): N

(Note: This represents the first 5 min. air break)
Press F5 Key.

Depth (fsw): 40
Time At Depth: 25
Gas Mix No.: **2**
Travel Rate: 60
Follow(Y/N): N

(Note: This represents the second 25 min. oxygen breathing period.)
Press F5 Key.

At this point the diver suffered an oxygen convulsion. From the point of interruption, simulate the divers' ascent to surface using air by entering the last dive segment as below:

Depth (fsw): 0
Time At Depth: 0
Gas Mix No.: **1**
Travel Rate: 60
Follow(Y/N): **Y**

Press F5 Key.

Use F6 key to **determine the required air decompression schedule, i.e., 40, 30, 20 and 10 fsw stop times to get to surface on air.**

**Points of Contact**

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In case of an emergency, a NMRI Undersea Medical Officer can be reached at (301)295-1839 or (301)295-5875.

# APPENDIX D

# USER TRAINING QUALIFICATION FOR NSW DIVE PLANNER V6.0

## USER TRAINING QUALIFICATION
## FOR NSW DIVE PLANNER V6.0

NAME:______________________________ SSN:__________________

1. Does the user know that the Dive Planner is restricted to qualified DMO use in support of United States Naval Special Warfare diving operations only?

2. Does the user know that in planning diving operations with the Dive Planner care must be taken to avoid exceptional exposure and simply unreasonable dives?

3. Does the user know that the Dive Planner may be used to calculate the decompression obligation for any phase or location (ie. the hangar, transfer trunk, hyperbaric chamber or the SDV itself) of the DDS/SDV operations?

4. Does the user know that the SDV operators must continue to use the CSMD procedures to calculate decompression requirements while on the mission and away from the DDS complex?

5. Is the user familiar with the V6.0 User's manual?

    a. General operating characteristics.
    b. Display parameters.
    c. Menu options: Use/Save/Delete/View/Print.
    d. Repetitive dive procedures/capability.
    e. Toggling between simultaneously running dive scenarios.

6. Does the user understand the concept of conditional/future risk?

7. Does the user understand that emphasis should be given to the following 4 points in the Dive Planner User's Manual?

    a. The "follow" option is set to "N" (No) for each segment of the dive done during the SDV operation.
    b. Once all segments of the dive are entered, the decompression schedule should be calculated by simulating the diver's ascent to the surface by entering a depth of "0", a time of "0", and setting the "follow" option to "Y".
    c. After "reaching the surface" the DMO should review the dive profile by using the F6 key. It is this "updated/final" decompression schedule that should be recommended to the Dive Supervisor.
    d. The F4 key can be used to "back-up" one segment at a time.

8. Does the user know that the DMO utilizing the Dive Planner should enter each segment of the dive (the depth-time-gas segment information) that the SDV and/or DDS divers actually did, as exactly as possible (without rounding-off) with the "follow" option set to "N" (No)?

9. Does the user know that the DMO utilizing the Dive Planner should enter "gas 2" (0.7 ata O2 in N2) for all segments during which the diver's breathed the LAR V or the MK 16?

10. Is the user able to differentiate air vs. 0.7 ata O2 in N2 decompression profiles?

11. Does the user know that there are essentially two methods of expediting decompression when utilizing the Dive Planner? First the diver may use the MK 16 to perform the "in-water" decompression stops as recommended by the Dive Planner (although the 0.7 ata O2 in N2 decompression schedule may be less conservative than the air decompression schedule). Secondly,the Dry Decompression Procedure using oxygen may be utilized.

12. Does the user know that in the event of computer failure or any difficulties with the Dive Planner program, the diver's decompression will be calculated using the CSMD procedures or as directed by the USN Dive Manual Volumes 1 & 2?

13. Does the user know that the repet. groups of the Dive Planner, CSMD, and Volumes 1 & 2 are not interchangeable?

14. Does the user know that the "clean time" using the Dive Planner is 18 hours?

15. Does the user know the procedure for saving dive profiles by year, month, day, location of the dive, and the number of the dive for that day respectively (ie. 961031S1 meaning a dive done on 31 Oct 1996 in the SDV - the first dive in the SDV on that day)?

16. Is the user aware of the procedures for consulting NMRI (24hour ph# 301-295-5875 or DSN# 295-5875) and NEDU (24hour ph# 904-230-3100 or DSN# 436-4351)?

________________________________________

(PRINT) Certifier's Name / Rank / Command

________________________________________

Certifier's Signature

________________________________________

Date